Breakout Session 2
Report-out presentations

Technical Topic Session: Standards and Protocols

Report-out Presentation

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Standards and Protocols

- Develop topic list for DOE Sponsored R&D for Microgrid related standards and protocols
- Discussed 18 topics for R&D in the Standards and Protocol area
- Consolidated into 12 topics
- Voted on priorities to the top 5, then consolidated into top 2
  1. Universal Microgrid Communications and Control Standards
  2. Microgrid Protection, Coordination, and Safety

1. Universal Microgrid Communications and Control Standards

- **Description of the R&D scope**
  - Clearly define an end-to-end communications and control standard that links the DG, loads, and utility connections (link EMS, BAS, Utility, microgrid controller, and industrial metering, market participation), WITH STANDARDIZED component capabilities (DR, BAS, diesels, loads, MCC, etc.) (standard schema or data structures), consistent with applicable cyber security standards

Universal Microgrid Communications and Control Standard Baseline vs. R&D Performance Targets

Technical Performance

Baseline	R&D Target	Application or Market Sector
• Every microgrid communications and control is custom. • Difficult to scale up. • Adds to microgrid business risk. • Adds to cost. • Can't expand easily later. • Don't have consistent capabilities from DER/BAS. • Standards are one asset at a time.	• Leverage interoperability to enable retrofit. • Easy BAS integration. • Microgrid can respond to ancillary signals and optimize system operations WITH low integration and design costs. • Allow interconnection as microgrid fleet.	Cross cuts across microgrid markets (Commercial, DOD, etc.) Covers 10MW and under

Cost of Performance

Baseline	R&D Target	Application or Market Sector
~$100k to integrate EACH building/DER/BAS right now.	$10k per BAS/building/DR?	

Universal Microgrid C2 Standard: Needs and Significance

- **Why the performance targets are needed**
  - Enable legacy equipment/systems participation in microgrids
  - Enable better market participation and capture multiple value steams.
  - Significantly reduce design and integration costs.
  - Simplify interconnection for microgrids.

- **Significance of the R&D performance targets**
  - Order of magnitude reduction in cost of implementation
  - Increase and accelerate commercial deployment
  - Benefits planning, deployment, and operations

Actionable Plan for Universal Microgrid Communications and Control Standards

- **Milestones, Schedules and End Goals**

2012 - 2013

– Develop plan to address interoperability of legacy equipment, BAS integration, DER fleet, and external signals with microgrids.

2014 - 2015

– Deploy demonstration of interoperability of legacy equipment, BAS integration, DER fleet, and external signals with microgrids

2015

– Harmonization with Standards activities.

Universal Microgrid C2 Standard: Synergistic Development

Synergistic Development

Related Project	Project Performer/Sponsoring Organization	Actions for Coordinated and Collaborated R&D
IEEE SCC21 Projects (1547 and 2030)	DOE	Smart Grid standards
NIST SGIP	NIST	Smart Grid standards

2. Microgrid Protection, Coordination and Safety

- **Description of the R&D scope**
  - R&D to modify existing anti-islanding DER techniques to operate correctly in microgrid operations. Develop new unintentional islanding techniques to handle larger numbers of DER in microgrid. Define acceptable anti-islanding requirements for microgrids that export power.
  - Develop new protection and coordination methods to handle faults and abnormal conditions when grid-connected and inside microgrids
  - Coordination disturbance response with utility
  - Development of protection and coordination practice in microgrids with high levels of inverter based DER

Microgrid Protection, Coordination and Safety: Baseline vs. R&D Performance Targets

Technical Performance

Baseline	R&D Target	Application or Market Sector
•Currently using 1547 for interconnection of DER •No standard for protection of microgrid with multiple DER units	•Standard on microgrids that addresses protection , reverse power flow, anti-islanding with multiple DER •Having standard way to implement protection with inverter-based DR	Cross cuts across microgrid markets (Commercial, DOD, etc.) Covers 10MW and under

Cost of Performance

Baseline	R&D Target	Application or Market Sector
$100Ks to perform interconnection studies for large scale DER/ugrid systems (approaching 100% for under 4MW)	Less than 5% of ugrid cost	

Microgrid Protection, Coordination and Safety: Needs and Significance

- **Why the performance targets are needed**
  - Standard on microgrids that addresses protection , reverse power flow, anti-islanding with multiple DER are needed to safely operate the power system in grid-connected and island mode
  - Since inverter based DER have little to no fault current, typical protection that uses overcurrent protection may not be applicable

- **Significance of the R&D performance targets**
  - Utilities will require proper protection and coordination of the microgrid systems
  - High penetration of RE and EV will require new protection strategies

Actionable Plan for Microgrid Protection, Coordination and Safety

- **Milestones, Schedules and End Goals**

  2012 - 2013

  – Develop plan to address protection, coordination, and safety with microgrids.

  2014 - 2015

  – Deploy demonstration of protection, coordination, and safety with microgrids

  2015

  – Publish best practices and standards in protection, coordination, and safety for microgrids.

Microgrid Protection, Coordination and Safety: Synergistic Development

Synergistic Development

Related Project	Project Performer/Sponsoring Organization	Actions for Coordinated and Collaborated R&D
CERTS	DOE	Have done R&D in protection
RDSI Microgrid Demos	DOE	Have done some demo of protection systems

Caveats & Other Matters of Importance

- **Caveats**
  - Standards Development Organizations take considerable time to reach consensus for the final standards approval, may be best to publish best practices based on real-world examples in interim
  - Other topics listed (out of the 18) should be given some more consideration, especially for longer term R&D issues and opportunities

- **Other Matters of Importance**
  - Demonstration Projects should showcase best practices
  - Need to understand what is happening in international standards in the microgrid area

Technical Topic Session: Systems Design and Economic Analysis

Report-out Presentation

By:

Steve Pullins, Horizon Energy Group

Prioritized List of R&D Areas

#	Score	Title
1	4	Design is not analysis; conceptual design is more pertinent here; analytic frameworks may be too limiting; analytics selected following agreed-upon design framework; Energy Master Plan (EMP) bounds the design problem
2	20	Multi-objective (quantitative metrics) nature of microgrid(s) must be acknowledged as conceptual design and all other operational aspects of the system is optimized; microgrid-specific design tools needed (as opposed to re-purposed existing products); suite of tools beginning from production tool models
3	18	Design and operation optimization under uncertainty (risk and return) for key variables (e.g. user behavior); “Stress test” of prelim op design against variety of external factors which threaten system operation
4	11	Architecture must be contusive to operational build out and expanded modes of operation, clearly recognizing all rev streams including post project completion; Initial design allows for multimode and changes post-completion
5	5	Dynamic and anticipatory interrelationship of storage (thermal and electrical) with key loads, generation (maintenance) environmental and external market factors; PEVs
6	1	Develop open protocol microgrid app and management system applications

Actionable Plan for Microgrid Multi-objective Optimization Framework

- **Description of the R&D scope**

  Multi-objective (based on quantitative metrics, e.g. reliability optimization, carbon minimization, ramp-rate limiting, demand charge reduction, lifecycle costs, etc.) over TIME (dynamic programming); nature of microgrid(s) must be acknowledged as conceptual design and all other operational aspects of the system are optimized; microgrid-specific design tools needed (as opposed to re-purposed existing products); grid-constrained production simulation models / tools

Microgrid Multi-objective Optimization Framework: Baseline vs. R&D Performance Targets

Technical Performance

Baseline	R&D Target	Application or Market Sector
Mixture of proprietary tools used as force-fit, some non-comprehensive microgrid tools, "grab what they can find" mentality	Comprehensive methodology for multi-objective microgrid design, gap analysis WRT current tools, suits the lifecycle of microgrid, supports open model framework for collaboration, maintenance, reuse	C&I, universities, and military

Cost of Performance

Baseline	R&D Target	Application or Market Sector
Spec'ing out components plus design for <10MW, about $250k-1M (for systems with legacy, LOTS of variability here) ,for small ones costs go down dramatically but are still proportionally high	5% for <1MW, 1 to 2.5% <10MW , >10MW is 1% of project cost	C&I, universities, and military (note: Current costs can make projects "no-go")

Microgrid Multi-objective Optimization Framework: Needs and Significance

- **Milestones and Schedules, Trendable to End Goals**
  - Tested framework by 2015 coming out of FOA
  - Institutionalized (widely adopted, e.g. by SDO) by 2020
  - Library of documents (metrics, algorithms, framework elements, etc.) and software (test cases, component models, etc.)
- **Why the performance targets are needed**
  - Institutionalized framework would drive costs down
  - Burdensome costs for smaller microgrids would be greatly improved
  - This would lead to more microgrids, especially in C&I sector
  - 15000 C&I sites in the US in the 4-40MW range
  - 8500 universities in the 1.5-40MW range
- **Significance of the R&D performance targets**
  - Supports SAIDI reduction targets and load outage targets

Microgrid Multi-objective Optimization Framework: Participant Roles

DOE	Other Federal Agency	Industry	Research Institutions (Universities, Nat'l labs)	Other
Develop the FOA, help develop the team that will institutionalize the results	NIST (SGIP) and DoD are on board with adoption of the framework	Bring cost share and direction -- consortium of C&I users and vendors	Supply R&D capabilities and IP to make the vision a reality	Regulatory agencies and market organizations that inform and encourage the project development

Microgrid Multi-objective Optimization Framework: Uniqueness and Synergistic Development

Uniqueness

Relevant Project	Project Performer/Sponsoring Organization	Uniqueness of Activity to the Listed Project
There are lots of one-offs (and that is the problem!)	DoD, DOE, industry	Nobody is developing the framework yet

Synergistic Development

Related Project	Project Performer/Sponsoring Organization	Actions for Coordinated and Collaborated R&D
National laboratories test facilities, NSF class 3 ERCs	Various	TBD

Actionable Plan for Design and Operations Optimization Methodology with Uncertainty

- **Description of the R&D scope**

  Design and operations optimization methodology under uncertainty (including financial risk and return) for key architecture and variables (e.g. user behavior, cyber security, fuel price, equipment failure, RPSs, climate, load characterization change); “Stress test” of preliminary operational design against a variety of external factors which threaten system operation; risk-resilient design

Actionable Plan for Design and Operations Optimization Methodology with Uncertainty

Technical Performance

Baseline	R&D Target	Application or Market Sector
Sensitivity analysis; engineering "judgment"; early beta products	Framework with allows comprehensive design; a suite of complimentary offerings; supports open model framework for collaboration, maintenance, reuse, must have V&V cachet so that people believe it	C&I, universities, and military

Cost of Performance

Baseline	R&D Target	Application or Market Sector
Judged not investment-worthy by commercial lenders	5% for <1MW, 1 to 2.5% <10MW , >10MW is 1% of project cost	C&I, universities, and military

Design and Operations Optimization Methodology with Uncertainty: Needs and Significance

- **Milestones and Schedules, Trendable to End Goals**
  - Tested optimization methodologies by 2015 coming out of FOA
  - Institutionalized (widely adopted, e.g. by SDO) by 2020
  - Methodology reference library
- **Why the performance targets are needed**
  - Comprehensive design optimization would reduce costs
  - Dynamic operations optimization would drive costs down
- **Significance of the R&D performance targets**
  - Supports emissions and system efficiency targets

Design and Operations Optimization Methodology with Uncertainty: Participant Roles

DOE	Other Federal Agency	Industry	Research Institutions (Universities, Nat'l labs)	Other
Develop the FOA, help develop the team that will institutionalize the results	NIST (SGIP) and DoD are on board with adoption of the framework	Bring cost share and direction -- consortium of C&I users and vendors	Supply R&D capabilities and IP to make the vision a reality	Regulatory agencies and market organizations that inform and encourage the project development

Design and Operations Optimization Methodology with Uncertainty: Uniqueness and Synergistic Development

Uniqueness

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There are lots of one-offs (and that is the problem!)	DoD, DOE, industry	Nobody is developing the framework yet

Synergistic Development

Related Project	Project Performer/Sponsoring Organization	Actions for Coordinated and Collaborated R&D
National laboratories test facilities, NSF class 3 ERCs	Various	TBD

Technical Topic Session: System Integration

Report-out Presentation

Presenter	
Joe Heinzmann	Altairnano
Session Lead	
Jason Stamp	Sandia
Technical Leads	
Juan Torres	Sandia
Phil Smith	Honeywell

#	Score	Title
2	9	**Physical testing and V&V at a facility before deployment**, with lots of flexibility to simulate Microgrid conditions (loads etc.) at various scales, HITL; Integrate R&D capability into exiting test beds (assess candidate microgrid projects); Installation and system functionality risk mitigation for retrofits, unexpected ground truth, especially in fixed price contracts
4	9	**Baseline use case framework guidelines for microgrids** (final system integration must support the ones needed for the Microgrid deployment); framework must translate abstract architectural sorts of use cases into practical ones that help proscribe legitimate assumptions and givens to support systems integration; Common lexicography for microgrid applications
5	1	**Microgrid project development sequence to manage stakeholder** and regulatory impacts as microgrid progresses closer to construction and operation (workflow, best practice compendium)
6	13	**Online EMS that considers uncertainty, optimizes grid performance for multiple objectives in real tim**e; Operations of clusters of microgrids (like several being run from one NOC); Integration with wide area monitoring (visualization) and operational tools like synchro-phasors, and the microgrid dynamic (operational) response, and dynamic pricing response
13	17	**Common framework cyber/control/physical architectures; cyber security architectures and controls, Vertically integrated information management systems, Unsuitability of communications protocols for Microgrid applications (IP best effort, big payloads, big pipe downstream, need bigger pipe upstream and smaller down, real-time mode); Microgrid common integration bus (similar to enterprise integration bus), also a power integration bus like DC sources and loads and other components**

Common Integration Framework Actionable Plan

- **Description of the R&D scope**
  - Common framework cyber/control/physical architectures; cyber security architectures and controls,
  - Vertically integrated information management systems, Means all of the devices in a system, storage, generation, RE, EMS, etc. Unsuitability of communications protocols for Microgrid applications (e.g. IP best effort, big payloads, big pipe downstream, need bigger pipe upstream and smaller down, need real time mode);
  - Microgrid common integration bus (similar to enterprise integration bus), also a
  - Power integration bus like common DC or AC sources and loads and other components

Common Integration Framework: Baseline vs. R&D Performance Targets

Technical Performance

Baseline	R&D Target	Application or Market Sector
Brute force; each integration is tailored and proprietary	Open, scalable architecture for cyber/control/physical, reflect maturity of microgrids with their own standardized set of practices, common language to promote compatibility, framework of physical and communication adapters	

Cost of Performance

Baseline	R&D Target	Application or Market Sector
Around 1/3 of total project cost	Drop by an order of magnitude (might be unrealistic); alternatively 10% of project value	

Common Integration Framework: Needs and Significance

- **Why the performance targets are needed**
  - Common or best practices of physical and communication architecture will reduce
    - Initial cost in NRE, installation, commissioning
    - Lifecycle costs in terms of, training, spares, maintenance and repairs
  - Common terminology will accelerate Microgrid understanding
- **Significance of the R&D performance targets**
  - Reduction in cost will make more Microgrids economically viable
  - Widen adoption of Microgrid deployment
    - Easier to compare and relate
    - Reduces learning curve

Common Integration Framework Actionable Plan:

- **Milestones and Schedules, Trendable to End Goals**

2013

- DOE Microgrid Workshops for various markets
  - Gather existing microgrid best practices/horror stories
- Analyze for common denominators
- Baseline Integration costs

2014

- Publish white paper with common integration framework guidelines

2015

- Comparative analysis between baseline and CIF Microgrid projects

Common Integration Framework Participant Roles

DOE	Other Federal Agency	Industry	Research Institutions (Universities, Nat'l labs)	Other
• More money than others • Host Microgrid workshops • Leverage Microgrid projects for baseline data	DOD-Microgrids information	Support Microgrid cost Survey	• Perform survey and analyze data • Provide CIF document	CHP reports from agencies i.e. CaPUC reports on Self Generation Program

Common Integration Framework: Uniqueness and Synergistic Development

Uniqueness

Relevant Project	Project Performer/Sponsoring Organization	Uniqueness of Activity to the Listed Project
Energy Surety Microgrid	DOE/Sandia	Focuses on Common Integration Framework

Synergistic Development

Related Project	Project Performer/Sponsoring Organization	Actions for Coordinated and Collaborated R&D
Military Microgrid lessons learned	DOE/DOD/Sandia	Utilize project template to cover other Microgrids

Caveats & Other Matters of Importance

- **Caveats**
  - Microgrids tend to be remarkably unique
  - Industry, microgrid developers and Hosts engagement is critical to the accuracy of the survey

- **Other Matters of Importance**

  Spark spread, energy reliability & Grid resiliency will be key motivators of the deployment of the Microgrid